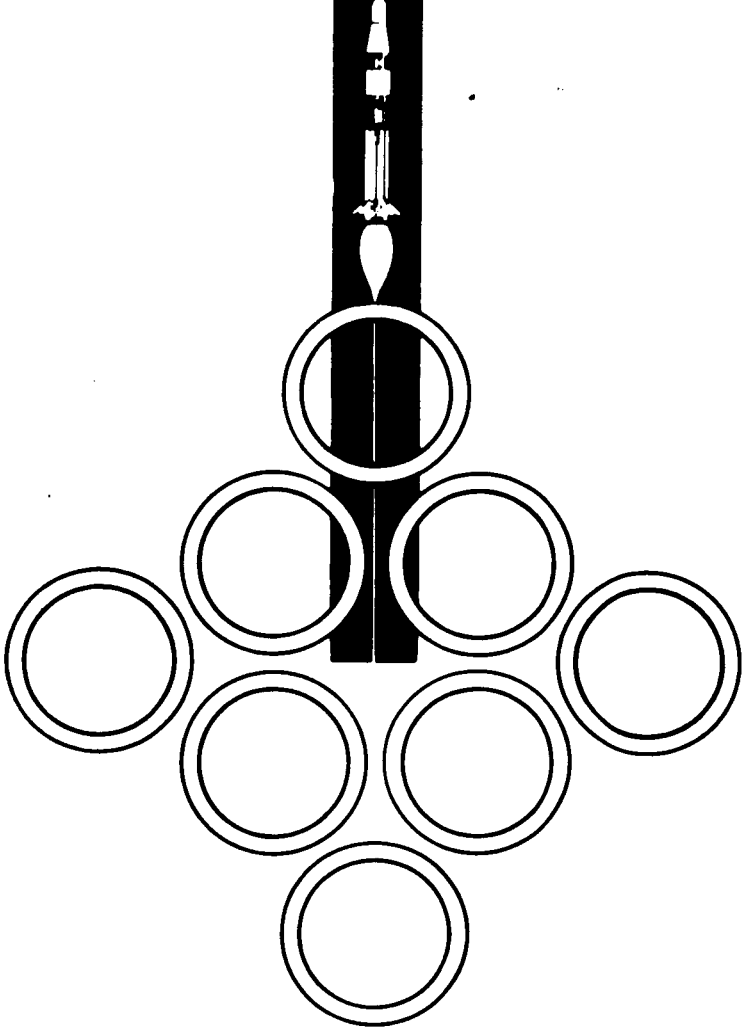

ENGINEERING DEPARTMENT

TECHNICAL REPORT

TR-RE-CCSD-FO-1078-3

April 3, 1967

SATURN IB PROGRAM

TEST REPORT
FOR

REFRIGERANT EXPANSION VALVE

ALCO Part Number TAC-45HW100

NASA Drawing Number 75M04406 PTR-8

SPACE DIVISION CHRYSLER CORPORATION

TEST REPORT

FOR

REFRIGERANT EXPANSION VALVE

ALCO Part Number TAC-45HW100

NASA Drawing Number 75M04406 PTR-8

ABSTRACT

This report presents the results of tests performed on one specimen of Refrigerant Expansion Valve 75M04406 PTR-8. The following tests were performed.

1. Receiving Inspection
2. Proof Pressure
3. Functional
4. Cycle

The specimen performance was in accordance with the specification requirements of NASA drawing 75M04406 PTR-8 throughout the test program with the exception of a small leak through the modulator casting. The leak did not effect specimen function.

TR-RE-CCSD-FO-1078-3

TEST REPORT

FOR

REFRIGERANT EXPANSION VALVE

ALCO Part Number TAC-45HW100

NASA Drawing Number 75M04406 PTR-8

April 3, 1967

CHRYSLER CORPORATION SPACE DIVISION - NEW ORLEANS, LOUISIANA

FOREWORD

The tests reported herein were conducted for the John F. Kennedy Space Center by Chrysler Corporation Space Division (CCSD), New Orleans, Louisiana. This document was prepared by CCSD under contract NAS 8-4016, Part VII, CWO 271620.

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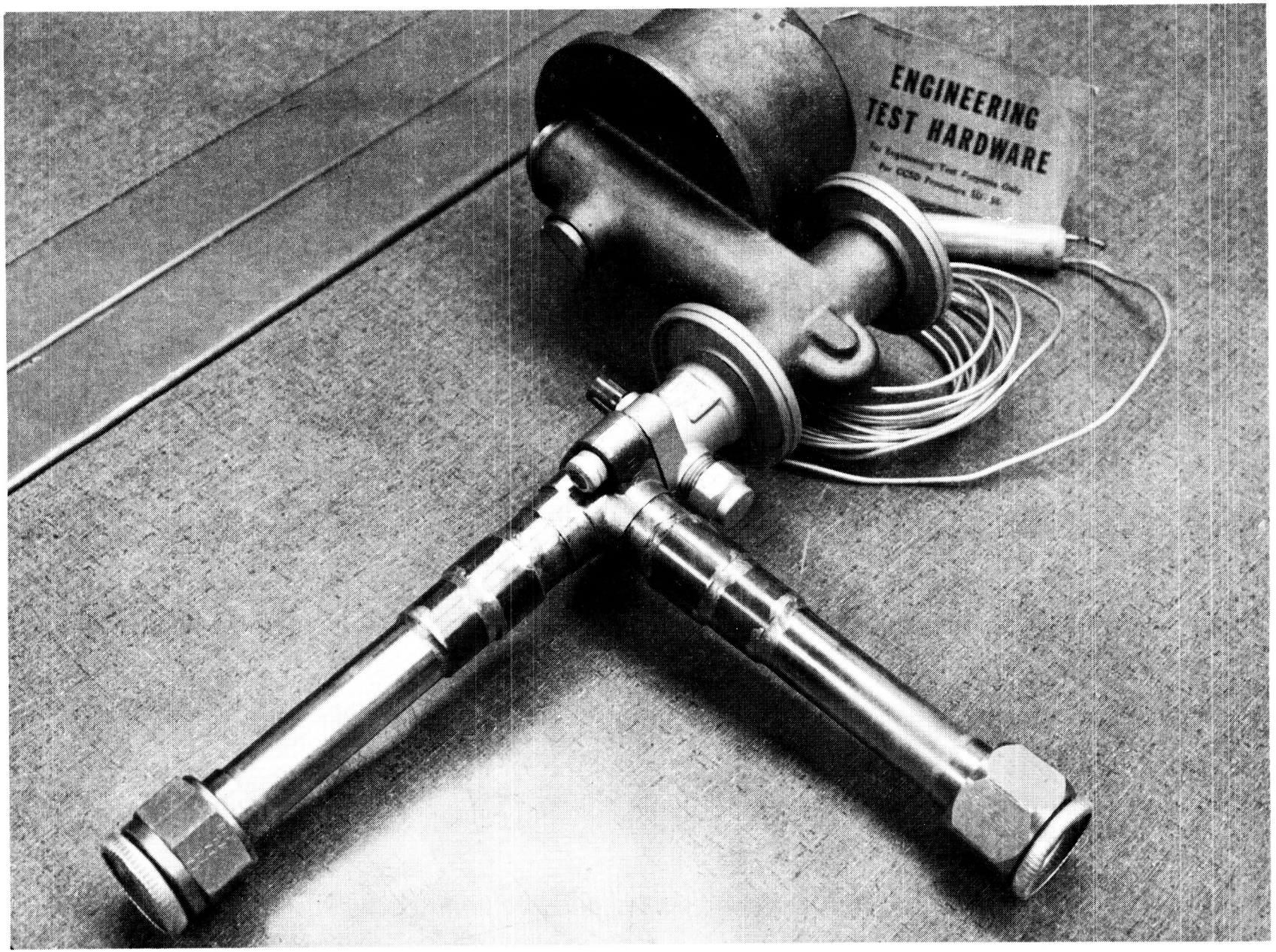


Refrigerant Expansion Valve, 75M04406 PTR-8

CHECK SHEET

FOR

REFRIGERANT EXPANSION VALVE

MANUFACTURER: ALCO Valve Co. and Johnson Service Co.
MANUFACTURER'S MODEL NUMBER: TAC-45HW100
NASA PART NUMBER: 75M04406 PTR-8
TESTING AGENCY: Chrysler Corporation Space Division, New Orleans, Louisiana
AUTHORIZING AGENCY: NASA KSC

I. FUNCTIONAL REQUIREMENTS

A.	OPERATING MEDIUM:	R-22
B.	OPERATING PRESSURE:	
	1. HEAD:	185 psig
	2. SUCTION:	55 psig
C.	PROOF PRESSURE:	
	1. INLET:	450 psig
	2. PNEUMATIC CONTROL INLET:	25 psig
D.	VALVE CAPACITY:	45 tons of refrigeration

II. CONSTRUCTION

A.	EQUALIZER:	1/4-inch SAE (Society of Automotive Engineers) male flare
B.	SIZE OF INLET AND OUTLET FITTINGS:	7/8-inch ODF (outer diameter female) and 1-1/8-inch ODM (outer diameter male)
C.	STYLE:	Straight through flow
D.	REMOTE BULB TUBING LENGTH:	15 ft.
E.	MODULATING ATTACHMENT:	Model V-306 **(Johnson Service Co.)**

III. ENVIRONMENTAL REQUIREMENTS

A.	EVAPORATOR TEMPERATURE RANGE:	-40 to +50°F
B.	BULB TEMPERATURE:	34°F

IV. LOCATION AND USE

The valve controls refrigerant flow to the evaporator in the air conditioning units on Launch Complexes 34 and 37B at the John F. Kennedy Space Center.

TEST SUMMARY

REFRIGERANT EXPANSION VALVE

75M04406 PTR-8

Environment	Units	Operational Boundary	Test Objective	Test Results	Remarks
Receiving Inspection	1	Comply with NASA drawing 75M04406 PTR-1	Determine compliance with NASA and vendor drawings and examine for defects and poor workmanship	Satisfactory	
Proof Pressure Test	1	Inlet and Outlet Ports: 450 psig for 5 min	Check for leakage	Satisfactory	No leakage
		Modulator: 25 psig for 5 min	Check for leakage	Slight leak through casting	No affect on function. Testing was continued.
Functional Test	1	185 psig head 55 psig suction	Monitor valve operation at different modulator signal pressures. Determine refrigerant flor through the valve.	Satisfactory	
Cycle Test	1	Full open to completely closed 5000 cycles	Determine if specimen performance is impaired by cycling	Satisfactory	

SECTION I

INTRODUCTION

1.1 SCOPE

This report presents the results of tests that were performed to determine if Refrigerant Expansion Valve 75M04406 PTR-8 meets the operational requirements for John F. Kennedy Space Center Launch Complexes 34 and 37B. A summary of the test results is presented on page vii.

1.2 ITEM DESCRIPTION

1.2.1 One specimen of Refrigerant Expansion Valve 75M04406 PTR-8 was tested. The valve controls the flow of refrigerant to the evaporator in the air conditioning units on Launch Complexes 34 and 37B at the John F. Kennedy Space Center.

1.2.2 Refrigerant Expansion Valve 75M04406 is a thermostatically controlled refrigerant valve, equipped with a pressure controlled modulator, and an external equalizer. The valve has a 45-ton refrigeration capacity.

1.2.3 The valve is manufactured by the ALCO Valve Company and is equipped with a Johnson Service Company modulating attachment.

1.3 APPLICABLE DOCUMENTS

The following documents contain the test requirements for Refrigerant Expansion Valve 75M04406 PTR-8.

a. 75M04406 PTR-8, component specification

b. KSC-STD-164(D), Environmental Test Methods

c. Test Plan CCSD-FO-1078-1F, test requirements

d. Test Procedure TP-RE-CCSD-FO-1078-2

SECTION II

RECEIVING INSPECTION

2.1 REQUIREMENTS

The specimen shall be visually and dimensionally inspected for conformance with NASA drawing 75M04406 PTR-8 and applicable specifications to the extent possible without disassembly of the test specimen. The specimen shall also be inspected for poor workmanship and manufacturing defects.

2.2 TEST PROCEDURE

A visual and dimensional inspection of the test specimen was performed to determine compliance with NASA drawing 75M04406 PTR-8 and the applicable vendor drawing to the extent possible without disassembly of the test specimen. At the same time the test specimen was also inspected for poor workmanship and manufacturing defects.

2.3 TEST RESULTS

The specimen complied with NASA drawing 75M04406 PTR-8. No evidence of poor workmanship or manufacturing defects was observed.

2.4 TEST DATA

The data presented in table 2-1 were recorded during the inspection.

Table 2-1. Specimen Specifics

Name	Expansion Valve
Manufacturer	ALCO Valve Co. and Johnson Service Company
Model	TAC-45HW100 V-306 modulating attachment
Capacity	45-tons refrigeration
Inlet and Outlet Port Size	1-1/8-inches OD 7/8-inches ID

SECTION III

PROOF PRESSURE TEST

3.1 TEST REQUIREMENTS

3.1.1 Pressurize the specimen inlet and outlet to 450 psig with GN_2 and maintain the pressure for 5 minutes. Check for any leakage or distortion.

3.1.2 Pressurize the pneumatic control inlet to 25 psig using GN_2 and maintain the pressure for 5 minutes. Check for any leakage or distortion.

3.1.3 The test specimen shall be depressurized to zero psig and inspected for distortion.

3.2 TEST PROCEDURE

3.2.1 The test setup was assembled as shown in figure 3-1 using the equipment listed in table 3-1.

3.2.2 All connections were tight, gages were installed and operating properly and all valves were closed.

3.2.3 Hand valves 3, 7, and 9 were opened.

3.2.4 The inlet and outlet ports were pressurized to 450 psig using hand regulator 5. The pressure was monitored on gage 8.

3.2.5 Hand valve 3 was closed. Pressure was maintained for 5 minutes and the specimen was checked for leakage and distortion.

3.2.6 Regulator 5 was adjusted to zero outlet pressure. Specimen pressure was allowed to vent to zero through the regulator.

3.2.7 Hand valves 7 and 9 were closed. Hand valve 3 was opened.

3.2.8 Regulator 5 was adjusted to 25 psig outlet pressure. The pressure was monitored on gage 6.

3.2.9 Hand valve 10 was cracked slightly allowing specimen modulator pressure indicated by gage 11 to reach 25 psig.

3.2.10 Hand valves 10 and 3 were closed. Specimen modulator pressure was maintained for 5 minutes. The specimen was checked for leaks and distortion.

3.2.11 Hand valve 10 was opened. Regulator 5 was adjusted to zero outlet pressure allowing modulator pressure to vent to zero through regulator 5.

3.2.12 All data were recorded.

3.3 TEST RESULTS

3.3.1 There was no evidence of leakage when the inlet and outlet ports were pressurized nor did any damage occur as a result of pressurization.

3.3.2 When pressurized to 25 psig a small leak developed in the modulator casting. It was still possible to surround the bellows with a 25 psig atmosphere so the leak did not affect the function of the valve. Testing was continued.

3.4 TEST DATA

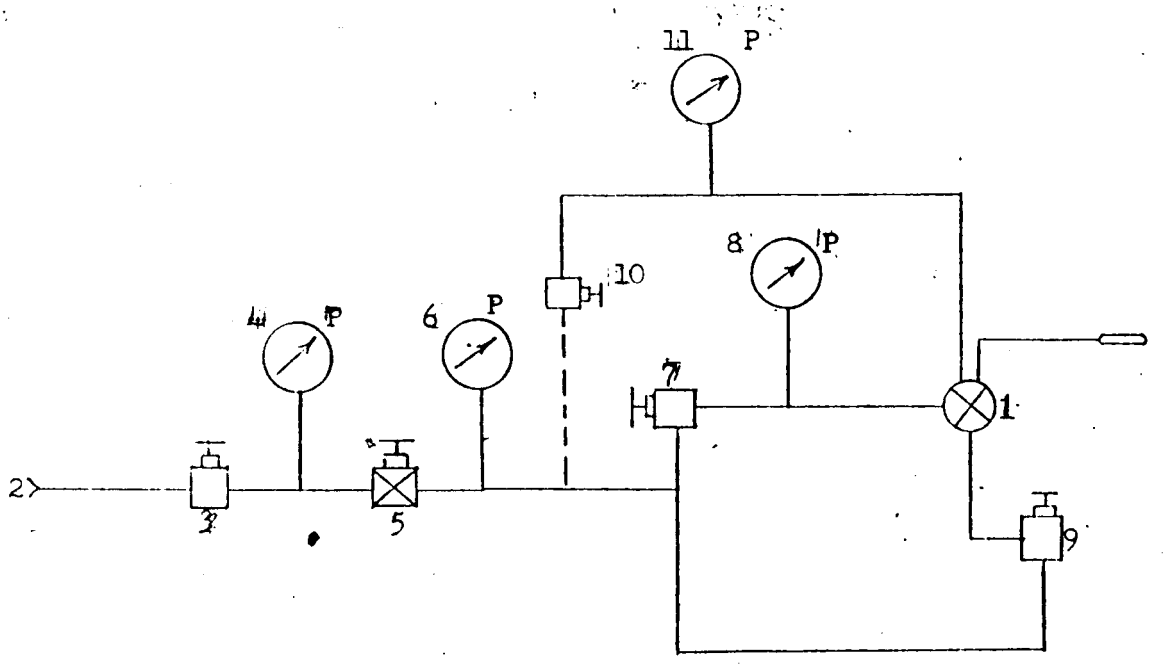
The data presented in table 3-2 were recorded during the test.

Table 3-1. Proof Pressure Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	ALCO and Johnson Service Co.	TAC-45HW100 and V306	NA	Refrigerant expansion valve 45-ton capacity
2	GN_2 Supply	Air Products	NA	NA	4000-psig bottle supply
3	Hand Valve	Kerotest	NA	NA	$\frac{1}{4}$-inch
4	Pressure Gage	Linde Co.	23771-1	NA	0 to 4000-psig $\pm$5% FS accuracy
5	Regulator	Linde Co.	Type 8962	NA	0 to 5000-psig outlet
6	Pressure Gage	Linde Co.	23218-1	NA	0 to 3000-psig $\pm$5% FS accuracy
7	Hand Valve	Marotta	HVA-16	105	1-inch
8	Pressure Gage	Duragauge	NA	NA	0 to 600-psig $\pm$0.5% FS accuracy Cal date 10-24-66
9	Hand Valve	Marotta	HVA-16	106	1-inch
10	Hand Valve	Robbins Aviation	NA	NA	$\frac{1}{4}$-inch
11	Pressure Gage	Heise	08-113-93-181	NA	0 to 30-psig $\pm$5% FS accuracy Cal date 12-27-66

Table 3-2. Proof Pressure and Leakage Test Data

Pressure	450 psig for 5 min (inlet and outlet ports)
Leakage	Zero
Distortion	None
Pressure	25 psig for 5 min (modulator)
Leakage	Small leak in modulator casting. Did not affect valve function.
Distortion	None



Note: Refer to table 3-1 for item identification.

Figure 3-1. Proof Pressure Test Schematic

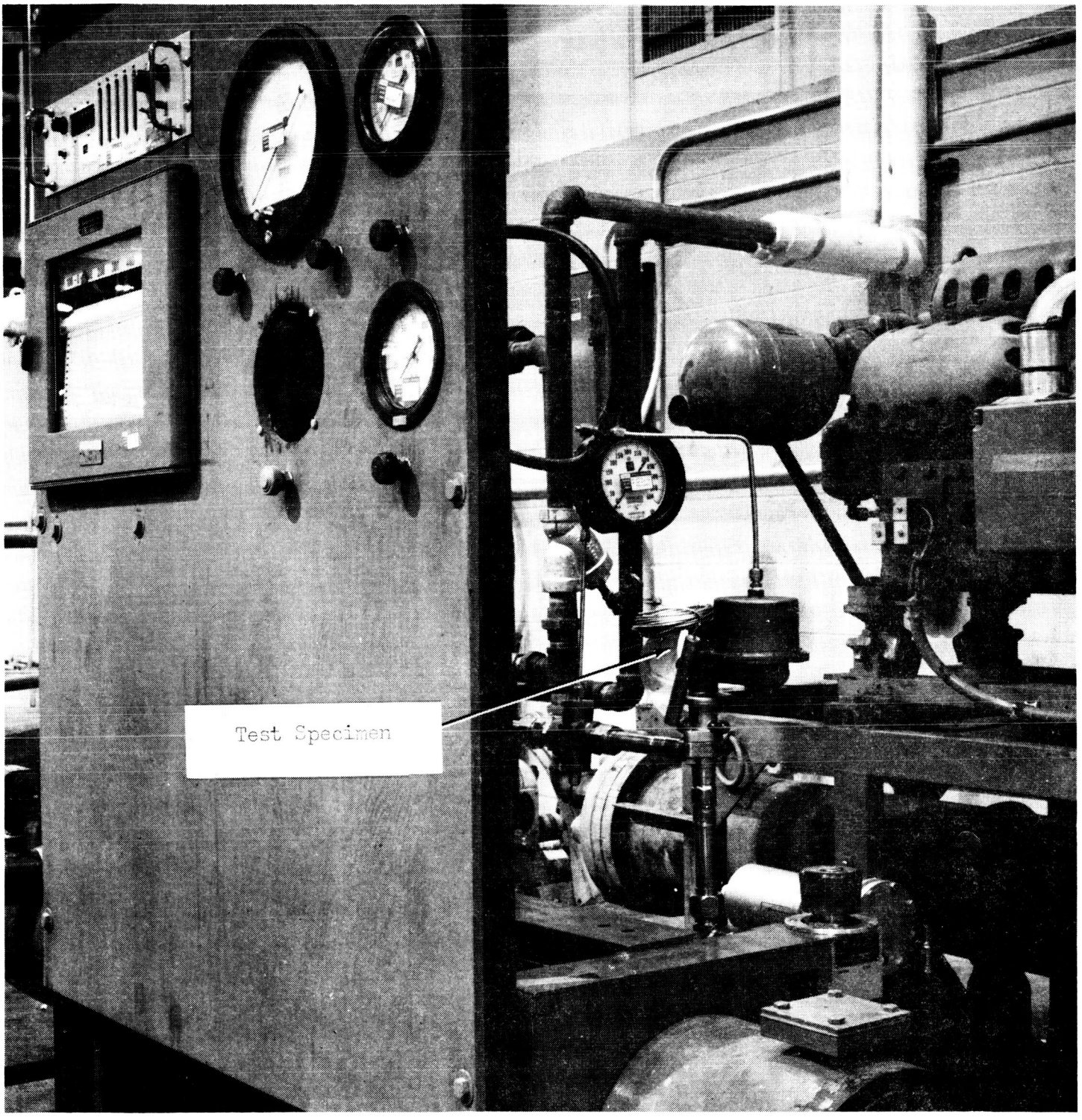


Figure 3-2. Proof Pressure Test Setup

SECTION IV

FUNCTIONAL TEST

4.1 TEST REQUIREMENTS

4.1.1 Manually adjust the expansion valve to control at a set point of 4°F superheat with a 20 psig signal pressure applied to the modulating attachment.

4.1.2 Slowly decrease the modulator signal pressure (from the initial 20 psig) until the superheat begins to increase, thus indicating that the modulating attachment is beginning to override the expansion valve.

4.1.3 Continue to decrease the modulator signal pressure until the valve is in the closed position. Record this pressure also.

4.1.4 Slowly increase the modulator signal pressure from 0 to 20 psig, recording both the point at which the valve begins to open and the point at which the valve is full open as signified by the superheat returning to a temperature of 4°F.

4.1.5 Perform steps 4.1.2 through 4.1.4 ten times initially and three times on all subsequent functional tests.

4.1.6 Divide the refrigerant flow at 100 per cent capacity (as determined in steps 4.1.2, 4.1.3, and 4.1.4), into fourths to determine approximate signal pressures simulating system operating capacities of 100, 75, 50, and 25 per cent.

4.1.7 Using signal pressures determined in step 4.1.6 suddenly fluctuate the signal pressure to the modulator causing the expansion valve to simulate changes in the system operating capacity from 100 to 75, 75 to 50, 50 to 25, 25 to 50, 50 to 75, and 75 to 100 per cent.

4.1.8 Perform step 4.1.7 three times.

4.1.9 During one functional determine the refrigerant flow through the test specimen varying the head pressure from the lowest attainable pressure to 200 psig while holding the suction pressure constant at 55 psig.

4.2 TEST PROCEDURE

4.2.1 The specimen was installed in the functional test setup as shown in figure 4-1, using equipment listed in table 4-1.

4.2.2 All connections were tight, gages were installed and operating properly, and all hand valves were closed.

4.2.3 Temperature recorder 35, flow indicators 8 and 47, and preamplifier 52 were turned on.

4.2.4 Hand valve 48 was opened and circulating pump 45 was turned on and the water/glycol flow was adjusted as required with bypass hand valve 44. The flow was monitored on flow indicator 47.

4.2.5 Hand valves 24, 33, 9, 15, 18, 6, and 13, and solenoid valve 31 were opened.

4.2.6 Hand regulator 26 was adjusted until 100 psig was indicated on gage 27.

4.2.7 Hand regulators 28 and 30 were adjusted pressurizing the modulator until 20 psig was indicated on gage 34.

4.2.8 Water flow through condenser 3 was adjusted to ensure proper operation.

4.2.9 Compressor 2 was turned on and loaded as required for the test.

4.2.10 The system was allowed to stabilize, temperature recorder 35, R-22 flow indicator 8, and suction pressure gage 16 were monitored. Water/glycol temperature was controlled with temperature controller 41.

4.2.11 The test specimen was adjusted to control at a set temperature of 4°F superheat with a 30°F bath.

4.2.12 Using hand regulator 30 the modulator was slowly depressurized until there was a decrease in R-22 flow as indicated by flow indicator 8. This pressure was recorded. A rise in superheat followed this decreased refrigerant flow.

4.2.13 The modulator was further depressurized with regulator 30 until zero flow was indicated by flow indicator 8. The pressure was recorded. The compressor suction pressure decreased to zero when the expansion valve was completely closed.

4.2.14 Using regulator 30 the modulator was slowly pressurized until flow was indicated by flow indicator 8. This pressure was recorded. Suction pressure began to increase when the expansion valve opened.

4.2.15 Using regulator 30 the modulator was further pressurized until maximum flow was indicated by flow indicator 8. This pressure was recorded. The superheat returned to 4°F signifying that the valve was full open.

4.2.16 Procedures 4.2.12 through 4.2.15 were performed ten times initially and three times on all subsequent functional tests.

4.2.17 The refrigerant flow was divided into fourths. The signal pressures needed to attain these flow values were determined and recorded.

4.2.18 Using signal pressures determined in procedure 4.2.18, the signal pressures were suddenly varied with regulator 30 to cause the

specimen to simulate changes in the system operating capacity from 100 to 75, 75 to 50, 50 to 25, 25 to 50, 50 to 75 and 75 to 100 per cent.

4.2.19 Procedure 4.2.18 was performed three times.

4.3 TEST RESULTS

4.3.1 The test specimen demonstrated satisfactory performance during the initial functional test. The thermal bulb and the pressure controlled modulator were effective in controlling the refrigerant flow.

The data did not appear consistent in the different phases of the functional test as a result of the many variables confronted during the test. Constant compressor load and heat load were maintained during all phases of the functional test. Closing the specimen with the modulator immediately caused the suction pressure to decrease. This decrease in suction pressure changed the flow rate through the specimen. A decrease in flow also caused the superheat to rise and the thermal bulb would react, opening the specimen further. With these variables it was difficult to obtain consistent data in all phases of the functional test.

The inconsistencies that occurred were a result of these variables and not a result of specimen malfunction.

4.4 TEST DATA

The data presented in table 4-2 were recorded during the initial functional test.

Table 4-1. Functional Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	ALCO and Johnson Service Co.	16HW100	NA	45-tons refrigeration
2	Compressor	Airtemp	DWW00	NA	100-ton unit
3	Condenser	Airtemp		4354	100-tons refrigeration
4	Dryer		C-969	NA	2-core
5	Sight Glass	Sporlan	5-A-12	NA	Built-in moisture indicator
6	Hand Valve	Marotta	HVA-16	106	1-inch
7	Flowmeter	Waugh	FL-12SB-1	NASA 08-113 106-1030 B	3/4-inch Cal date 10-14-66
8	Flow Indicator	Beckman	5311	NASA 08-113 018771	Preset input Cal date 2-1-67
9	Hand Valve	Robbins Aviation	SSKA 250-4T	NA	$\frac{1}{4}$-inch
10	Gage	Marsh	100-4S	NASA 08-113 95-1180-B	0 to 300-psig $\pm$0.5% FS accuracy Cal date 11-9-66
11	Thermocouple	Honeywell	"T" Type	NA	Cu-con
12	Capillary Tube	NA	NA	NA	
13	Hand Valve	Marotta	HVA-16	105	1-inch
14	Evaporator	Airtemp		E-204-583	50-tons refrigeration
15	Hand Valve	Robbins Aviation	SSKA-250-4T	NA	$\frac{1}{4}$-inch
16	Gage	Marsh	NA	NASA 08-113 95-1151B	0 to 200-psig Cal date 10-24-66

Table 4-1. Functional Test Equipment List (Continued)

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
17	Thermocouple	Honeywell	"T" Type	NA	Cu-con
18	Hand Valve	NA	NA	NA	$\frac{1}{4}$-inch
19	Hand Valve	NA	NA	NA	$\frac{1}{4}$-inch
20	Capillary Tube	NA	NA	NA	
21	Expansion Valve	Sporlan	MVE-34 GJ	NA	34-tons refrigeration
22	Hand Valve	NA	NA	NA	1-inch
23	GN_2 Supply	NA	NA	NA	4000-psig bottle
24	Hand Valve	Linde Co.	NA	NA	$\frac{1}{4}$-inch
25	Gage	Linde Co.	NA	NA	0 to 4000-psig $\pm$5% FS accuracy
26	Regulator	Linde Co.	Type R-8962	NA	0 to 5000-psig outlet
27	Gage	Oxweld	Bu 2581 AQ-2377-1-1	NA	0 to 4000-psig $\pm$5% FS accuracy
28	Pressure Regulator	Grove	15LX	L-41512	6000-psig inlet 0 to 750-psig outlet
29	Pressure Limiter	Republic	680-ID2	NA	15 to 250-psig
30	Pressure Regulator	Watts	M-119-3	NA	450-psi inlet
31	Solenoid Valve	Marotta	MV-74	17211	3-way, 28V DC
32	Pressure Limiter	Republic	680-ID-2	NA	15 to 250-psig
33	Hand Valve	Robbins Aviation	SSKA-250-4T	NA	$\frac{1}{4}$-inch
34	Pressure Gage	Heise	H41917	NASA 08-113 1087-C	0 to 30-psig $\pm$0.1% FS accuracy Cal date 12-27-66

Table 4-1. Functional Test Equipment List (Continued)

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
35	Temperature Recorder	Honeywell	NA	S470-421 1003	Range: -125 to +525°F Cal date 10-11-67
36	Process Water Supply	NA	NA	NA	80-psig
37	Penn Flow Regulator	Penn	1500	CA-64	2-inch, 150-psig
38	Process Water Return	NA	NA	NA	
39	Hand Valve	Jenkins	Fig 47	NA	1½-inch
40	Water/Glycol Solution	NA	NA	NA	20°F freezing point
41	Temperature Controller	Honeywell	NA	NA	
42	Pressure Actuated Valve	Honeywell	4805	768-794037	1-inch
43	Steam Heater	NA	NA	NA	
44	Hand Valve	Ohio Brass	15c	NA	2½-inch
45	Water Pump	Novo	17M2	T4503	Centrifugal 85-gpm
46	Turbine Flowmeter	Cox	AN-24	NASA 08-113 200812-15	1½-inch **Cal date 2/3/67**
47	Flow Indicator	Beckman	5311	NASA 08-113 016578	Cal date 12-29-66
48	Hand Valve	Williams	Fig 1254	NA	1¼-inch
49	Thermocouple	Honeywell	"T" Type	NA	Cu-con
50	Hand Valve	Williams	Fig 1254	NA	2-inch

Table 4-1. Functional Test Equipment List (Continued)

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
51	Thermocouple	Honeywell	"T" Type	NA	Cu-con
52	Preamplifier	Unholtz-Dickie	8 PMCV	NASA 08-113-0215-97-14	Cal date 12-19-66
53	Pressure Gage	Ashcroft	Duragauge	NASA 08-113-1403B	0 to 200-psig ±0.5% FS accuracy Cal date 9-22-66
54	Counter	Durant	NA	NA	0 to 99,999
55	Pressure Switch	Barksdale Valve	420E	NA	Range: 5-to 80-psig
56	Power Supply	Laboratory Supply	NA	NA	28V DC

Table 4-2. Initial Functional Test Data

Note: The following conditions were recorded at the beginning of the functional test.

T_1 (°F)	T_2 (°F)	T_3 (°F)	T_4 (°F)	Flow H_2O/ Glycol (gpm)	Flow R-22 (gpm)	R-22 Head Pressure (psig)	R-22 Suction Pressure (psig)	Modulator Sig Press. (psig)
39	100	32	62	9.5	33.0	200	52	20

T_1 - Water/glycol evaporator exit temperature.

T_2 - Refrigerant temperature upstream from test specimen.

T_3 - Temperature of gaseous refrigerant on suction line.

T_4 - Water/glycol evaporator inlet temperature.

Refrigeration Capacity (%)	Modulator Signal Pressure (psig)
100	14.0
75	12.3
50	9.4
25	8.1

Modulator Signal Pressures at Various Valve Positions

	Begin Close (psig)	Completely Closed (psig)	Begin Open (psig)	Full Open (psig)
1)	13.9	6.5	6.5	14.6
2)	13.8	6.5	6.5	14.5
3)	13.8	6.5	6.5	14.5
4)	13.9	6.5	6.5	14.5
5)	14.0	6.5	6.5	14.6
6)	14.0	6.5	6.5	14.6
7)	14.0	6.5	6.5	14.7
8)	14.0	6.5	6.5	14.7
9)	14.1	6.5	6.5	14.7
10)	14.1	6.5	6.5	14.7

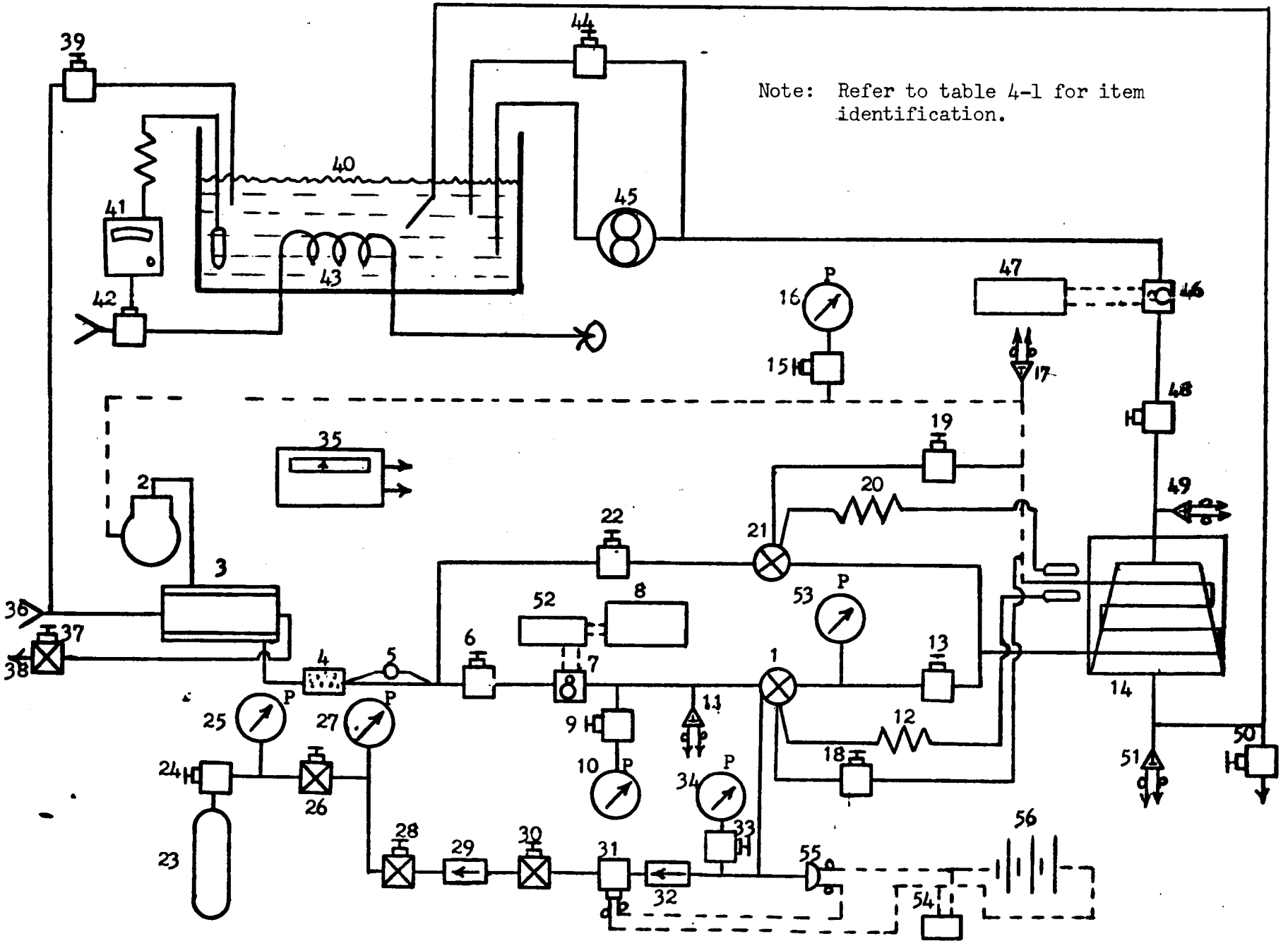


Figure 4-1. Functional Test Schematic

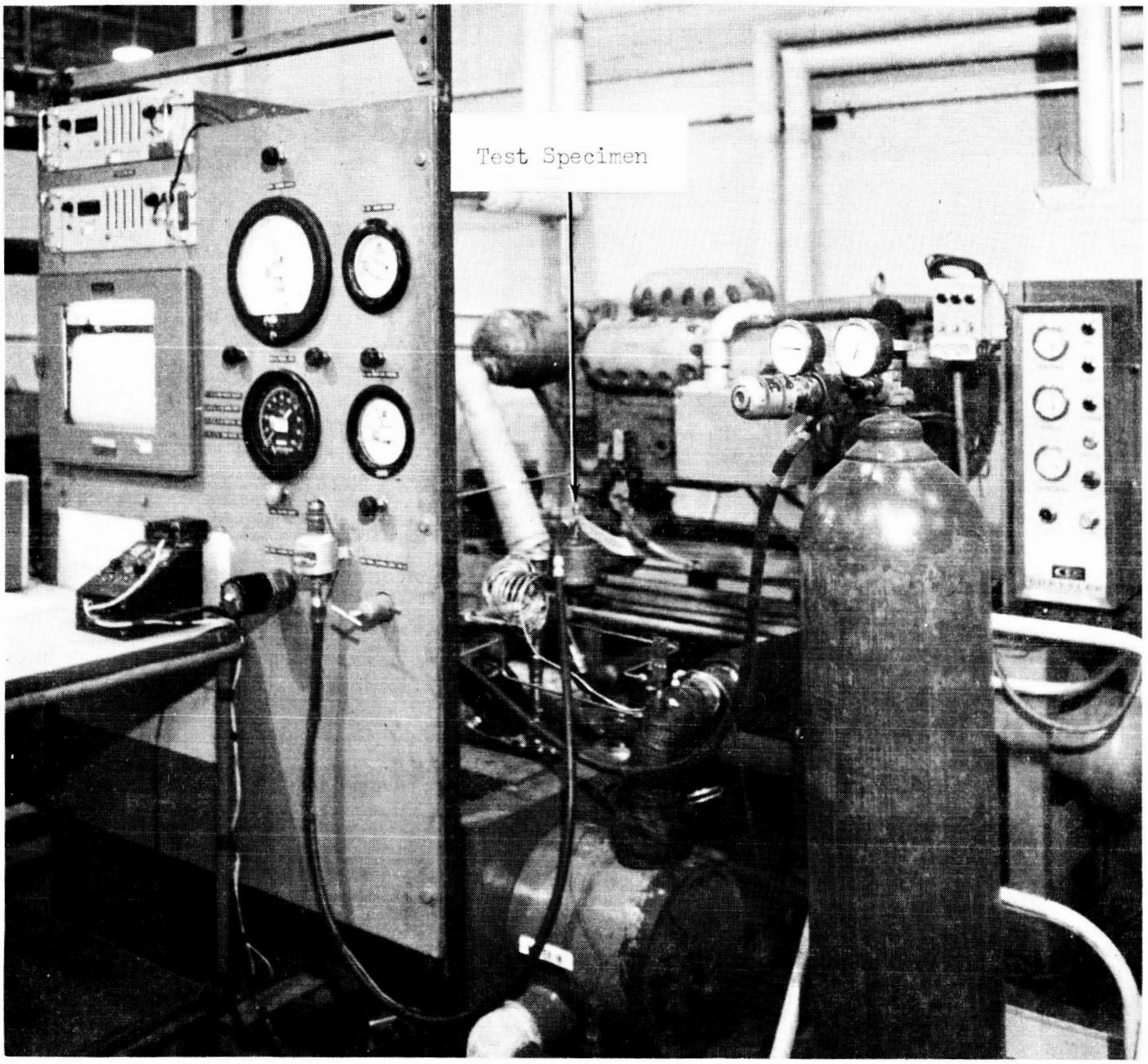


Figure 4-2. Functional And Cycle Test Setup

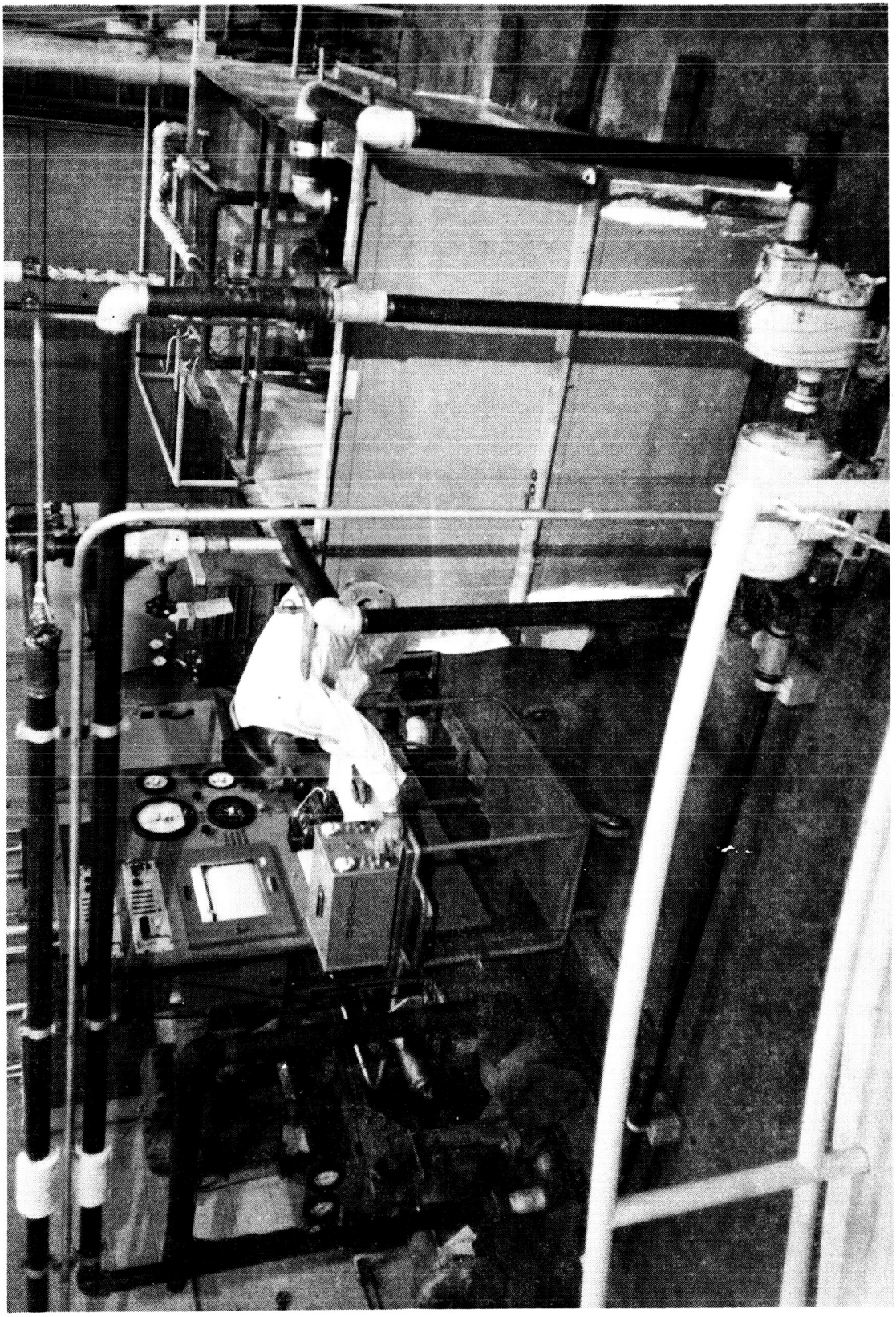


Figure 4-3. Functional And Cycle Test Setup

SECTION V

CYCLE TEST

5.1 TEST REQUIREMENTS

5.1.1 Cycle valve from full open to closed position. Conduct 5000 cycles and perform a functional test after 100, 500, 1000 and each additional 1000 cycles thereafter.

5.1.2 Record all adjustments necessary during functional testing.

5.1.3 The test is to be performed with R-22 as the test medium.

5.2 TEST PROCEDURE

5.2.1 The specimen was installed in the existing refrigeration system as shown in figure 4-1 using the equipment listed in table 5-1.

5.2.2 All connections were tight, gages were installed and operating properly and all hand valves were closed.

5.2.3 Hand valves 24 and 33, and solenoid valve 31 were opened. Pressure switch 55 was bypassed.

5.2.4 Regulator 26 was adjusted until 100 psig was indicated on gage 27.

5.2.5 Regulators 28 and 30 were adjusted until 20 psig was indicated on gage 34.

5.2.6 Pressure switch 55 was connected and actuate and deactuate pressures were adjusted to correspond with full open and full closed position of the valve.

5.2.7 A functional test was performed as outlined in section IV at 100, 500, 1000 and each 1000 cycles thereafter. A total of 5000 cycles were performed.

5.2.8 During one functional test the thermal bulb was disconnected for the suction line and secured so that it remained at constant room ambient temperature. Using Penn regulator 37, the compressor head pressure was varied from the lowest attainable pressure to 200 psig in 10 psig increments. The refrigerant flow for each increment was recorded while the suction pressure was held constant at 55 psig.

5.3 TEST RESULTS

The test specimen exhibited no degradation of performance as a result of the cycle test. The required functional tests were performed as outlined in section IV and the data were obtained under conditions described in paragraph 4.3.

5.4 TEST DATA

The data obtained during the functional test are presented in tables 5-2 through 5-8. Flow test data are presented in table 5-9.

Table 5-1. Cycle Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	ALCO and Johnson Service Co.	16HW100	NA	45-tons refrigeration
2	Compressor	Airtemp	DWW00	NA	100-ton unit
3	Condenser	Airtemp		4354	100-tons refrigeration
4	Dryer		C-969	NA	2-core
5	Sight Glass	Sporlan	5-A-12	NA	Built-in moisture indicator
6	Hand Valve	Marotta	HVA-16	106	1-inch
7	Flowmeter	Waugh	FL-12SB-1	NASA 08-113 106-1030 B	3/4-inch Cal date 10-14-66
8	Flow Indicator	Beckman	5311	NASA 08-113 018771	Preset input Cal date 2-1-67
9	Hand Valve	Robbins Aviation	SSKA 250-4T	NA	$\frac{1}{4}$-inch
10	Gage	Marsh	100-4S	NASA 08-113 95-1180-B	0 to 300-psig $\pm$0.5% FS accuracy Cal date 11-9-66
11	Thermocouple	Honeywell	"T" Type	NA	Cu-con
12	Capillary Tube	NA	NA	NA	
13	Hand Valve	Marotta	HVA-16	105	1-inch
14	Evaporator	Airtemp		E-204-583	50-tons refrigeration
15	Hand Valve	Robbins Aviation	SSKA-250-4T	NA	$\frac{1}{4}$-inch
16	Gage	Marsh	NA	NASA 08-113 95-1151B	0 to 200-psig Cal date 10-24-66

Table 5-1. Cycle Test Equipment List (Continued)

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
17	Thermocouple	Honeywell	"T" Type	NA	Cu-con
18	Hand Valve	NA	NA	NA	¼-inch
19	Hand Valve	NA	NA	NA	¼-inch
20	Capillary Tube	NA	NA	NA	
21	Expansion Valve	Sporlan	MVE-34 GJ	NA	34-tons refrigeration
22	Hand Valve	NA	NA	NA	1-inch
23	GN_2 Supply	NA	NA	NA	4000-psig bottle
24	Hand Valve	Linde Co.	NA	NA	¼-inch
25	Gage	Linde Co.	NA	NA	0 to 4000-psig ±5% FS accuracy
26	Regulator	Linde Co.	Type R-8962	NA	0 to 5000-psig outlet
27	Gage	Oxweld	Bu 2581 AQ-2377-1-1	NA	0 to 4000-psig ±5% FS accuracy
28	Pressure Regulator	Grove	15LX	L-41512	6000-psig inlet 0 to 750-psig outlet
29	Pressure Limiter	Republic	680-ID2	NA	15 to 250-psig
30	Pressure Regulator	Watts	M-119-3	NA	450-psi inlet
31	Solenoid Valve	Marotta	MV-74	17211	3-way, 28V DC
32	Pressure Limiter	Republic	680-ID-2	NA	15 to 250-psig
33	Hand Valve	Robbins Aviation	SSKA-250-4T	NA	¼-inch
34	Pressure Gage	Heise	H41917	NASA 08-113 1087-C	0 to 30-psig ±0.1% FS accuracy Cal date 12-27-66

Table 5-1. Cycle Test Equipment List (Continued)

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
35	Temperature Recorder	Honeywell	NA	S470-421 1003	Range: -125 to +525°F Cal date 10-11-67
36	Process Water Supply	NA	NA	NA	80-psig
37	Penn Flow Regulator	Penn	1500	CA-64	2-inch, 150-psig
38	Process Water Return	NA	NA	NA	
39	Hand Valve	Jenkins	Fig 47	NA	1½-inch
40	Water/Glycol Solution.	NA	NA	NA	20°F freezing point
41	Temperature Controller	Honeywell	NA	NA	
42	Pressure Actuated Valve	Honeywell	4805	768-794037	1-inch
43	Steam Heater	NA	NA	NA	
44	Hand Valve	Ohio Brass	15c	NA	2½-inch
45	Water Pump	Novo	17M2	T4503	Centrifugal 85-gpm
46	Turbine Flowmeter	Cox	AN-24	NASA 08-113 200812-15	1½-inch
47	Flow Indicator	Beckman	5311	NASA 08-113 016578	Cal date 12-29-66
48	Hand Valve	Williams	Fig 1254	NA	1¼-inch
49	Thermocouple	Honeywell	"T" Type	NA	Cu-con
50	Hand Valve	Williams	Fig 1254	NA	2-inch

Table 5-1. Cycle Test Equipment List (Continued)

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
51	Thermocouple	Honeywell	"T" Type	NA	Cu-con
52	Preamplifier	Unholtz-Dickie	8 PMCV	NASA 08-113-0215-97-14	Cal date 12-19-66
53	Pressure Gage	Ashcroft	Duragauge	NASA 08-113-1403B	0 to 200-psig ±0.5% FS accuracy Cal date 9-22-66
54	Counter	Durant	NA	NA	0 to 99,999
55	Pressure Switch	Barksdale Valve	420E	NA	Range: 5-to 80-psig
56	Power Supply	Laboratory Supply	NA	NA	28V DC

Table 5-2. Functional Test Results After 100 Cycles

Note: The following conditions were recorded at the beginning of the functional test.

T_1 (°F)	T_2 (°F)	T_3 (°F)	T_4 (°F)	Flow H_2O/ Glycol (gpm)	Flow R-22 (gpm)	R-22 Head Pressure (psig)	R-22 Suction Pressure (psig)	Modulator Sig. Press. (psig)
37	100	33	61	33.1	9.2	200	53	20

T_1 - Water/glycol evaporator exit temperature.

T_2 - Refrigerant temperature upstream from test specimen.

T_3 - Temperature of gaseous refrigerant on suction line.

T_4 - Water/glycol evaporator inlet temperature.

Refrigeration Capacity (%)	Modulator Signal Pressure (psig)
100	13.8
75	12.3
50	9.4
25	8.5

Modulator Signal Pressures at Various Valve Positions

	Begin Close (psig)	Completely Closed (psig)	Begin Open (psig)	Full Open (psig)
1)	13.8	6.9	6.9	14.2
2)	13.7	6.9	6.9	14.3
3)	13.9	7.0	7.0	14.4

Table 5-3. Functional Test Results After 500 Cycles

Note: The following conditions were recorded at the beginning of the functional test.

T_1 (°F)	T_2 (°F)	T_3 (°F)	T_4 (°F)	Flow H_2O/ Glycol (gpm)	Flow R-22 (gpm)	R-22 Head Pressure (psig)	R-22 Suction Pressure (psig)	Modulator Sig Press. (psig)
38	101	35	61	34.1	9.1	200	52	20

T_1 - Water/glycol evaporator exit temperature.

T_2 - Refrigerant temperature upstream from test specimen.

T_3 - Temperature of gaseous refrigerant on suction line.

T_4 - Water/glycol evaporator inlet temperature.

Refrigeration Capacity (%)	Modulator Signal Pressure (psig)
100	14.0
75	12.3
50	9.4
25	8.1

Modulator Signal Pressures at Various Valve Positions

	Begin Close (psig)	Completely Closed (psig)	Begin Open (psig)	Full Open (psig)
1)	13.8	6.5	6.5	14.6
2)	14.0	6.5	6.5	14.6
3)	14.0	6.5	6.5	14.6

Table 5-4. Functional Test After 1000 Cycles

Note: The following conditions were recorded at the beginning of the functional test.

T_1 (°F)	T_2 (°F)	T_3 (°F)	T_4 (°F)	Flow H_2O/ Glycol (gpm)	Flow R-22 (gpm)	R-22 Head Pressure (psig)	R-22 Suction Pressure (psig)	Modulator Sig. Press. (psig)
39	100	33	62	33.5	9.7	198	52.5	20

T_1 - Water/glycol evaporator exit temperature.

T_2 - Refrigerant temperature upstream from test specimen.

T_3 - Temperature of gaseous refrigerant on suction line.

T_4 - Water/glycol evaporator inlet temperature.

Refrigeration Capacity (%)	Modulator Signal Pressure (psig)
100	13.1
75	11.5
50	8.5
25	6.5

Modulator Signal Pressures at Various Valve Positions

	Begin Close (psig)	Completely Closed (psig)	Begin Open (psig)	Full Open (psig)
1)	13.5	5.0	5.0	13.8
2)	13.1	5.0	5.0	13.6
3)	13.1	5.0	5.0	13.9

Table 5-5. Functional Test Results After 2000 Cycles

Note: The following conditions were recorded at the beginning of the functional test.

T_1 (°F)	T_2 (°F)	T_3 (°F)	T_4 (°F)	Flow H_2O/ Glycol (gpm)	Flow R-22 (gpm)	R-22 Head Pressure (psig)	R-22 Suction Pressure (psig)	Modulator Sig. Press. (psig)
37	102	31	60	33.5	9.4	200	52	20

T_1 - Water/glycol evaporator exit temperature.

T_2 - Refrigerant temperature upstream from test specimen.

T_3 - Temperature of gaseous refrigerant on suction line.

T_4 - Water/glycol evaporator inlet temperature.

Refrigeration Capacity (%)	Modulator Signal Pressure (psig)
100	13.0
75	11.5
50	6.5
25	5.8

Modulator Signal Pressures at Various Valve Positions

	Begin Close (psig)	Completely Closed (psig)	Begin Open (psig)	Full Open (psig)
1)	13.1	4.5	4.5	13.5
2)	13.0	4.5	4.5	13.7
3)	13.0	4.5	4.5	13.7

Table 5-6. Functional Test Results After 3000 Cycles

Note: The following conditions were recorded at the beginning of the functional test.

T_1 (°F)	T_2 (°F)	T_3 (°F)	T_4 (°F)	Flow H_2O/ Glycol (gpm)	Flow R-22 (gpm)	R-22 Head Pressure (psig)	R-22 Suction Pressure (psig)	Modulator Sig. Press. (psig)
37	99	32	65	29.6	9.3	194	53	20

T_1 - Water/glycol evaporator exit temperature.

T_2 - Refrigerant temperature upstream from test specimen.

T_3 - Temperature of gaseous refrigerant on suction line.

T_4 - Water/glycol evaporator inlet temperature.

Refrigeration Capacity (%)	Modulator Signal Pressure (psig)
100	13.1
75	11.0
50	8.0
25	5.7

Modulator Signal Pressures at Various Valve Positions

	Begin Close (psig)	Completely Closed (psig)	Begin Open (psig)	Full Open (psig)
1)	13.1	5.0	5.0	14.0
2)	13.1	5.0	5.0	14.5
3)	13.0	5.0	5.0	14.5

Table 5-7. Functional Test Results After 4000 Cycles

Note: The following conditions were recorded at the beginning of the functional test.

T_1 (°F)	T_2 (°F)	T_3 (°F)	T_4 (°F)	Flow H_2O/ Glycol (gpm)	Flow R-22 (gpm)	R-22 Head Pressure (psig)	R-22 Suction Pressure (psig)	Modulator Sig Press. (psig)
38	102	31	62	33.5	9.5	200	52.5	20

T_1 - Water/glycol evaporator exit temperature.

T_2 - Refrigerant temperature upstream from test specimen.

T_3 - Temperature of gaseous refrigerant on suction line.

T_4 - Water/glycol evaporator inlet temperature.

Refrigeration Capacity (%)	Modulator Signal Pressure (psig)
100	13.1
75	11.7
50	8.0
25	5.2

Modulator Signal Pressures at Various Valve Positions

	Begin Close (psig)	Completely Closed (psig)	Begin Open (psig)	Full Open (psig)
1)	13.1	4.0	4.0	14.1
2)	13.1	4.0	4.0	14.1
3)	13.1	4.0	4.0	14.1

Table 5-8. Functional Test Results After 5000 Cycles

Note: The following conditions were recorded at the beginning of the functional test.

T_1 (°F)	T_2 (°F)	T_3 (°F)	T_4 (°F)	Flow H_2O/ Glycol (gpm)	Flow R-22 (gpm)	R-22 Head Pressure (psig)	R-22 Suction Pressure (psig)	Modulator Sig. Press. (psig)
38	102	31	62	33.5	9.5	200	52.5	20

T_1 - Water/glycol evaporator exit temperature.

T_2 - Refrigerant temperature upstream from test specimen.

T_3 - Temperature of gaseous refrigerant on suction line.

T_4 - Water/glycol evaporator inlet temperature.

Refrigeration Capacity (%)	Modulator Signal Pressure (psig)
100	13.1
75	11.7
50	8.0
25	5.2

Modulator Signal Pressures at Various Valve Positions

	Begin Close (psig)	Completely Closed (psig)	Begin Open (psig)	Full Open (psig)
1)	13.1	4.0	4.0	14.1
2)	13.1	4.0	4.0	14.1
3)	13.1	4.0	4.0	14.1

Note

The following data were obtained by maintaining a constant 55 psig suction pressure at the exit of the evaporator. Head pressure was varied from 161 psig to 200 psig.

Table 5-9. Refrigerant Flow Versus Head Pressure

Head Pressure (psig)	R-22 Flow (gpm)
161	9.4
168	9.5
180	10.0
190	10.3
200	11.0

APPROVAL

TEST REPORT

FOR

REFRIGERANT EXPANSION VALVE

ALCO Part Number TAC-45HW100

NASA Drawing Number 75M04406 PTR-8

SUBMITTED BY

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